Wyoming's Uranium Resource

Summary Report
February 2014

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Photo courtesy of John Veevaert, Trinity Mineral Co.

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Introduction

Uranium provides a natural source of heat inside the Earth's crust. This concentrated energy source, found in numerous minerals, is highly valued for its use in nuclear power and electrical generation.

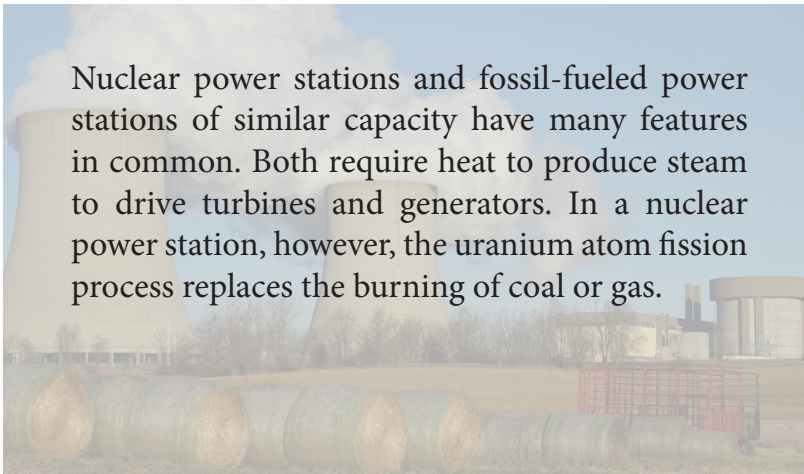
Wyoming is home to the largest known economic uranium ore reserves in the United States. In the 1980s, Wyoming's uranium mining industry was hit hard due to a drop in price, but today the state is poised to make a comeback with 24 mining operations in the planning or permitting phase.

Wyoming ranks No. 1 among uranium producing states, accounting for approximately 54 percent of the more than 5 million pounds of yellowcake (U_3O_8) produced nationwide in 2013. Last year in the United States uranium was also produced in Nebraska, Texas, and Utah. Leading world producers include Kazakhstan, Canada, and Australia.

Wyoming Mines and Production

Currently, there are four active uranium mining operations in Wyoming. Three are located in the Powder River Basin in northeast Wyoming and one in the Great Divide Basin, which occupies the northeastern region of the Greater Green River Basin in southwestern Wyoming. All four employ the in-situ recovery mining method (page 2). The Smith Ranch-Highland, operated by Cameco-owned Power Resources, has been in continuous operation since the early 1990s. In late 2012, Uranium One, Inc. resumed uranium mining at what was previously known as the Irigary and Christensen Ranch operations; these two areas are now considered one operation, named Willow Creek, situated along the Johnson-Campbell county line in the western Powder River Basin. In May 2013, mining commenced at Cameco's North Butte operation near Pumpkin Buttes in Campbell County, and in August mining began at Ur-Energy's Lost Creek mine in northeastern Sweetwater County (see map on back cover).

All totaled, yellowcake production in Wyoming (2013 projection) was approximately 2.5 million tons, a figure that will likely be surpassed in 2014, with more mining operations set to come online this year and beyond.



Nuclear power stations and fossil-fueled power stations of similar capacity have many features in common. Both require heat to produce steam to drive turbines and generators. In a nuclear power station, however, the uranium atom fission process replaces the burning of coal or gas.

A Brief History

Our knowledge of nuclear energy began more than 100 years ago when researchers discovered the properties of atoms in a variety of naturally-occurring materials. Alpha and beta particles, as well as X- and gamma-rays were discovered to have originated from single atoms. This set the stage for decades of pioneering scientific research into the power within the atoms' nuclei. It also caused the first boom in the price of radioactive materials such as radium (Ra), as well as the value of such elements based on their location and whether they were economically viable for extraction from the Earth's crust.

The first discovery of uranium in Wyoming was in 1918 at the Silver Cliff mine near Lusk (Niobrara County). The ore was actually referred to as "radium ore," as that was the sought-after commodity at the time, but the Silver Cliff ore was also rich in uranium, silver, and copper.

Scientific research dominated the interest in uranium until the 1930s when its vast potential energy and power were eventually harnessed in the race to acquire nuclear weapons. The first nuclear weapon was created by the U.S. during World War II (1939-1945). Following that period, during the Cold War the United States was in a nuclear arms race with the Soviet Union.

Beginning in 1957, nuclear power was also put to use in peaceful ways, most notably in the form of electrical generation, but also in medical treatments and other technological applications designed to benefit to society.

How is Uranium Produced

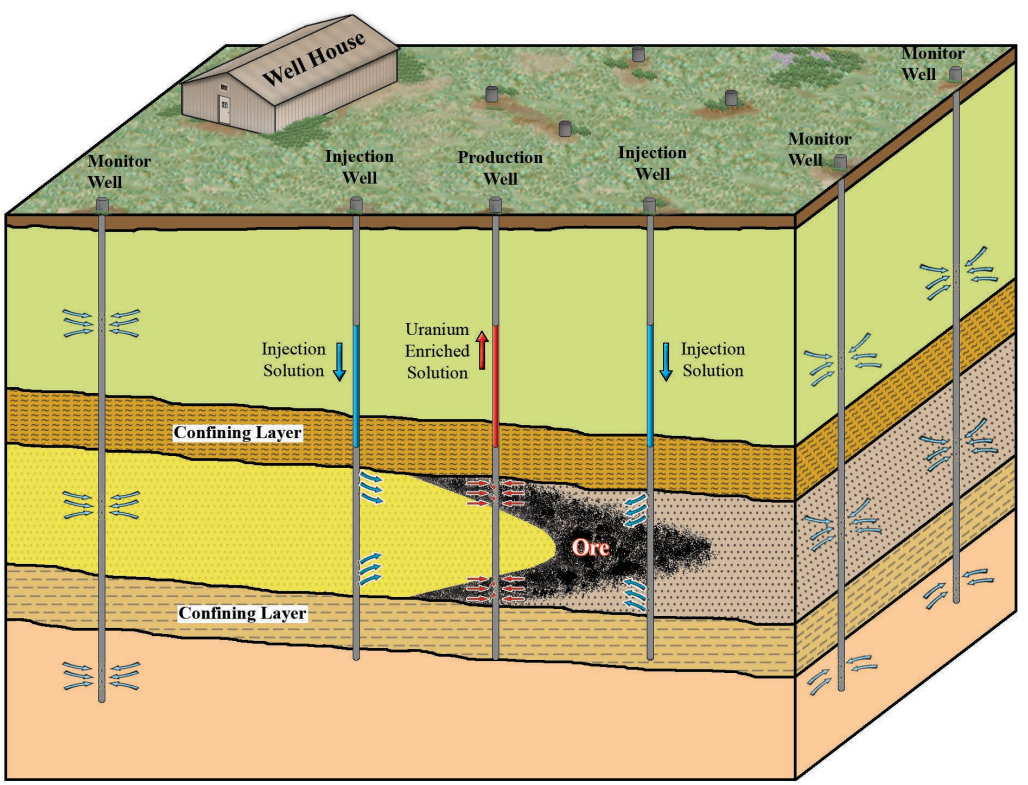
Uranium occurs in countless minerals and rocks in the Earth's crust. The question is whether the element can be mined and extracted from those rocks in amounts that are considered economically viable.

In Wyoming, uranium ore is extracted from the ground using in-situ recovery, a sophisticated underground mining technique. Most uranium deposits in Wyoming are easily "mineable" with little disturbance to the environment, particularly on the surface using in-situ recovery methods.

In-situ recovery involves 1) pumping water up to the surface from the reservoir in which the ore is found, 2) adding oxidizing agents such as bicarbonate – water with oxidizing agents added is called lixiviant – 3) injecting the oxygen-rich water back into the subsurface to mobilize the uranium, and finally 4) pumping the uranium-laden lixiviant back to the surface for extraction of the uranium.

The in-situ recovery method has a huge advantage over underground or surface/open pit mining (both conventional mining techniques). In-situ recovery mining does not require removing millions of tons of rock and soil in order to extract the uranium resource. Uranium is removed from the rock while still in the subsurface, thus reversing the process by which the uranium ore deposit originally formed millions of years ago.

On the surface at the in-situ recovery mine, uranium is extracted from the lixiviant by a process called ion exchange. Further chemical processing produces concentrated uranium oxide (U_3O_8), which is known as yellowcake. This is the form in which uranium is sold from the mining company to the utility companies that produce electricity. The uranium then undergoes additional treatment; conversion to a gaseous state, followed by enrichment to fuel grade concentrations, and finally fuel fabrication of various types for various nuclear reactor designs.



In-situ recovery mining of uranium. Millions of years ago, natural processes transported oxygen-rick groundwater and deposited uranium into sandstones and other similar porous rocks. In-situ recovery was designed to reverse those processes to extract uranium back out of the rocks, but completed in a carefully controlled process engineered to minimize environmental impacts. *Graphic by James R. Rodgers.*

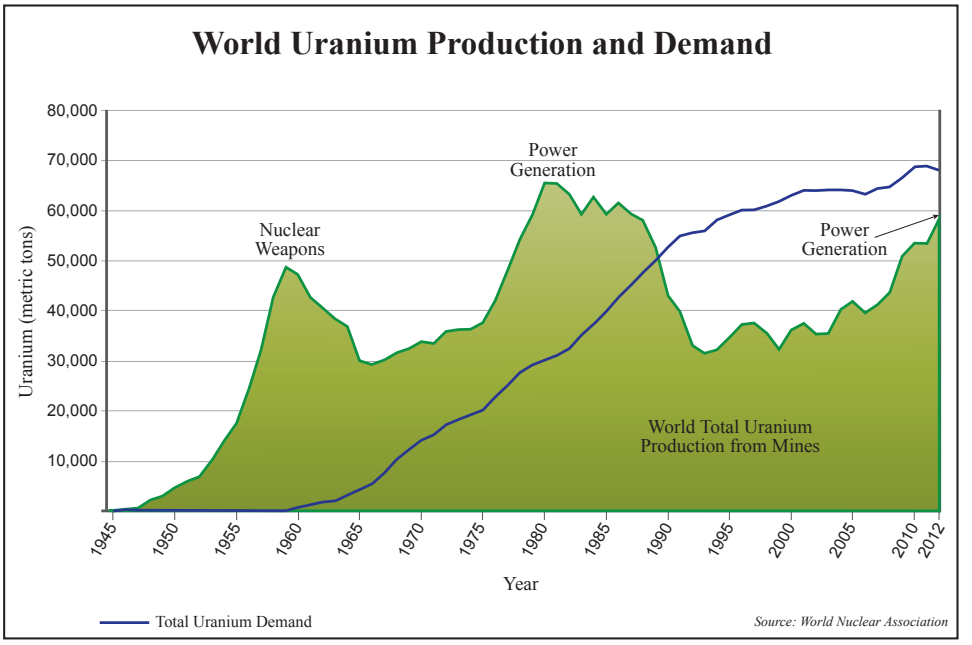
Clean Energy Source

Nuclear energy is recognized as a practical, inexpensive, and clean (emission free) source of energy. A typical 1,000 megawatt reactor can provide enough electricity for a modern city of up to 1 million people, according to the World Nuclear Association.

There are several reasons why nuclear power is becoming more attractive. It is cleaner and more reliable than many energy sources. There are no CO_2 emissions from nuclear power plants; what is seen coming from a plant's massive towers is actually water vapor.

Nuclear power also boasts the best capacity factor of all forms of electricity generation. Capacity factor refers to the amount of time that a power plant is able to run at full capacity. A nuclear power plant has a capacity factor well above 90 percent compared to a coal-fired power plant with about 64 percent, or a natural gas powered plant at about 43 percent; hydroelectric is 40 percent, and other renewables are well below that number.

Nuclear power is also gaining more favor due to the vast technological improvements in reactor design as well as safety.



Uranium requirements since WWII: The shortfall in uranium production (gap between production and demand since about 1990) has been filled by finite secondary supplies. *Graphic by James R. Rodgers.*

A Gap in Supply and Demand

The growth in uranium for electrical generation is due in part to the forecast growth in energy consumption worldwide, a more than 50 percent increase expected in the next 25 years. At the same time, more and more countries are turning to nuclear energy to meet their growing electricity demands.

The United States is a net importer of uranium. Current uranium needs for the nation is in excess of 50 million pounds of yellowcake annually, which is about 10 times the amount of what is actually produced in the U.S. Only a few countries are net exporters of uranium (consume less than they produce), which makes uranium a global commodity.

Forecasts point to a large gap worldwide between primary supply (uranium mining) and demand (reactors for power generation). This gap has historically been filled with secondary supply from such sources as excess inventories, including those held by the U.S. Department of Energy. However, secondary supply is becoming more limited. The United States-Russia Megatons-to-Megawatts Program – conversion of weapons-grade uranium into fuel for nuclear power plants – expired last year.

According to the Wyoming Mining Association, with new operations coming online in the state, Wyoming could potentially produce as much as five-million pounds of uranium this year. Whether the state's uranium makes it to market is largely up to the federal government. If the U.S. allows the marketplace to fill the gap, rather than dip into its own stockpiles, Wyoming could significantly contribute to filling the gap in supply and demand.

A Commodity Resource

U.S. uranium reserves are strongly dependent on price. Uranium supply shortages or even the perception of such shortages is expected to drive prices higher which in turn will lead to more exploration and ultimately increased production.

With Wyoming's 24 potential development projects under review the state is well positioned to provide for what is forecast to be an increase in demand worldwide for uranium used for electrical generation.

U.S. uranium reserves are strongly dependent on price. The majority of uranium ore in the United States comes from deposits in sandstone, which tend to be of lower grade than deposits mined in other countries such as Australia and Canada. When uranium prices drop, the U.S. lower grade uranium deposits tend to be less profitable, thus having an impact on the rate and amount of uranium recovered.

In 2013, the uranium spot price ranged from $34.00 to $43.75. Although uranium spot prices have been in an overall decline since reaching record highs in 2007, most experts agree that the large gap between worldwide demand and supply of yellowcake will apply upward pressure to prices in the future.

Sources

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U.S. Energy Information Administration
USEC, Inc.
Nuclear Energy Institute
World Nuclear Association

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For additional information, scan this QR code to access the WSGS uranium website.

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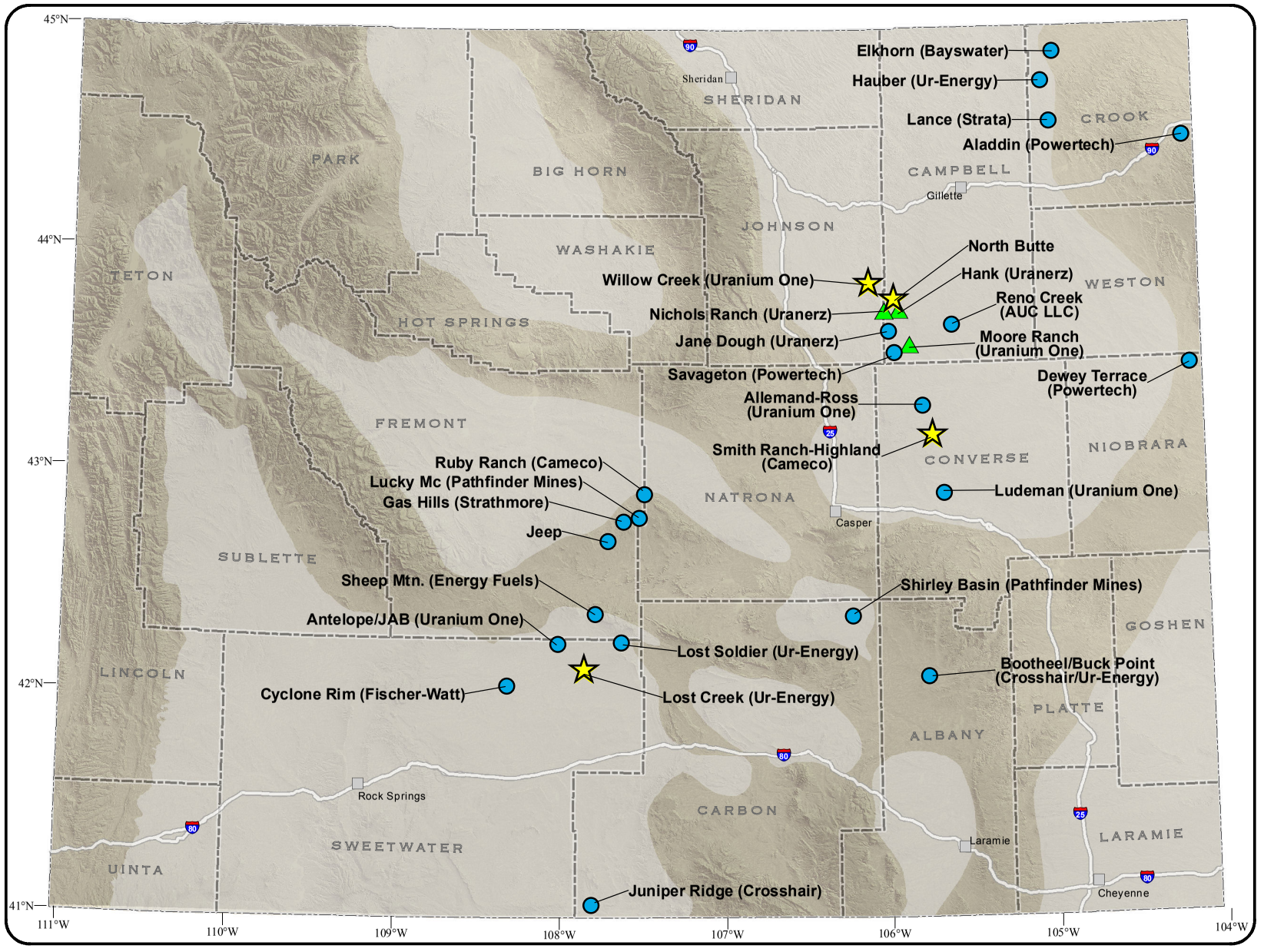
Geology - Interpreting the past - Providing for the future



EXPLANATION

Energy Basins

Current uranium projects

Currently producing

Permitted, production in less than 2 yrs

Permitting, proposed, exploratory

City or town

Interstate highway

County boundary

N

0 10 20 40 Miles

0 15 30 60 Kilometers

Wyoming Uranium Projects

Map design and layout by Phyllis Ranz 2/2014